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Project Summary

Evaluation of a Process to Convert Biomass to Methanol Fuel

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The report describes numerous design considerations that were reviewed, design modifications made, and preliminary results from operating a pilot-scale facility to develop, demonstrate, and evaluate the Hynol Process, a high-temperature, high-pressure method for converting biomass into methanol fuel. The University of California, Riverside, College of Engineering-Center for Environmental Research and Technology (CE-CERT) constructed a reactor capable of gasifying approximately 50 lb/hr of biomass. The design for the reactor was developed for the U.S. Environmental Protection Agency (EPA) by an engineering consulting company under a separate contract. Significant design flaws were discovered and corrected during the project.

This Project Summary was developed by the National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Producing methanol from biomass offers significant environmental, energy, and economic advantages over other liquid fuel resources. Methanol is cleaner-burning than gasoline, so its widespread use can contribute to air quality improvements in urban areas. The fuel also can be produced from domestic renewable resources, which brings advantages in emissions of greenhouse gases, energy security, local jobs, and fuel distribution.

The Hynol Process originated at the Department of Energy's Brookhaven National Laboratory as a method for increasing the yield of fuel from conversion of biomass. Originally conceived to operate with a coal feedstock, the process has been applied to coprocessing biomass with fossil fuels, coal, oil, and gas at high temperature and high pressure. The process produces methanol, a liquid fuel that can be used for transportation, industrial processes, electrical power generation, and military needs. Bench-scale studies by others indicate that the Hynol Process could be economically competitive with petroleum because of its high carbon conversion efficiency (~87%).

The Hynol Process involves three phases: (1) Reaction of biomass in a hydrogasifier, also referred to as a hydropyrolizer (HPR); (2) Steam pyrolization of the resulting gas, which produces a synthesis gas; and (3) Methanol synthesis, which leaves a recycle gas that can be returned to the HPR and waste heat that can be returned to the steam pyrolizer.

In this project, the College of Engineering-Center for Environmental Research and Technology (CE-CERT) at the University of California, Riverside, constructed a pilot-scale Hynol Process facility according to a design developed by an engineering consultant to the EPA under a separate project. CE-CERT discovered numerous flaws in the design. These flaws were evaluated and corrected, at substantial cost and with significant delays to the original project plan. CE-CERT performed some experiments with the reactor, but additional modifications are recommended before the pilot-scale facility can fulfill its original mission of demonstrating and characterizing the Hynol Process with a variety of renewable feedstocks.

Procedure

From the specifications for construction of the Hynol Process facility, CE-CERT discovered significant errors in numerous systems, components, and processes, including:

- Hydropyrolysis reactor refractory material.
- Burner management system.
- Secondary air system.
- Low-pressure igniter.
- Burner vessel.
- Biomass feed system conveyor.
- Biomass feed system overflow chutes.
- Feed system storage containers.
- Electrical controls.
- Gas supply and measurement system.
- Steam flow metering.
- Nitrogen pulse heater.
- Bed height measurement methodology.
- Flow calculation methodology.
- Cooling system.
- Solenoid valves.
- Exit flare stack.
- Heat exchanger.
- Sample system.

CE-CERT conducted experiments and tests on systems, components, and subsystems. When a system, component, or subsystem was found to be deficient for any reason, CE-CERT investigated possible remedies and implemented the choice that would provide for maximum safety, performance, and cost-effectiveness. Modifications were completed in December 1999, and the first full-scale gasification experiments took place in January 2000. White oak wood chips were used as the biomass for these experiments.

Results and Discussion

The first gasification experiments were impaired by alkali problems and agglomeration of sand, which was mixed with the biomass in the fluidized bed. Changes to materials injected with the biomass solved these problems.

Gasification was achieved, but steady-state operation was not. Modifications to the heating system and a review of the material used as refractory may be necessary to achieve steady-state operation.

Overall carbon conversion efficiency was not calculated because the gasifier did not achieve steady-state operation.

Conclusions

Further research, and possibly a redesign of some components and materials, is necessary before the Hynol Process can be demonstrated at the pilot scale with a variety of feedstocks.

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The complete report, entitled "Evaluation of a Process to Convert Biomass to Methanol Fuel," (Order No. PB2001-101231; Cost: $51.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 605-6000
(800) 553-6847 (U.S. only)

The EPA Project Officer can be contacted at:

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